



Performance Assessment of the Portsmouth On Site Waste Disposal Facility

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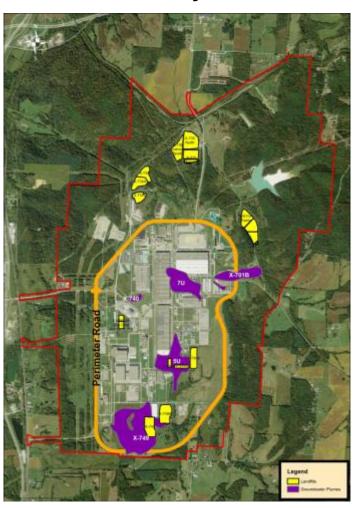
DOE Portsmouth

P&RA CoP Technical Exchange Meeting Richland, WA 16 December 2015

PORTS End-State Vision



Today



Post Remediation



OSWDF Overview



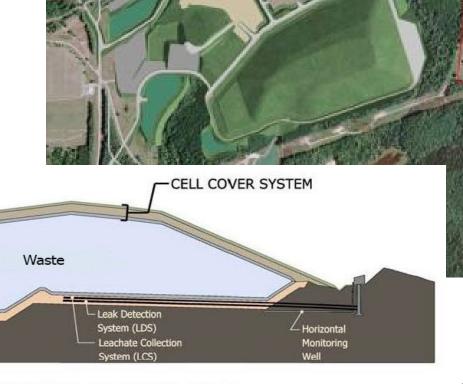
Key Features of OSWDF

- ➤ ~100-acre liner footprint with 10 cells and 2 contingent cells
- On competent bedrock and 100 feet above the upper most aquifer
- Over 5 million cubic yards of waste capacity
- Accept LLW, MLLW, TSCA, and classified wastes

CELL LINER SYSTEM

Gravity drain with a leachate treatment plant

Leachate Collection Valve House



Performance Summary – Base Case

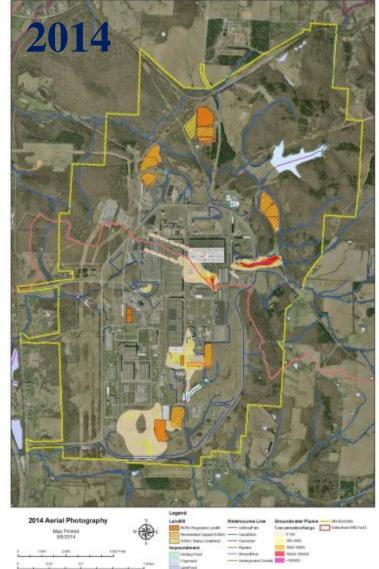


Performance Objective	Limit	PA R	esult					
		0 to 1,000 years	1,000 to 10,000 years					
DOE Order 435.1 IV.P.(1)(a)	≤ 25 mrem/year	1.5E-14 mrem/year	0.002 mrem/year					
"All Pathways"	TEDE whole body							
DOE Order 435.1 IV.P.(1)(b)	≤ 10 mrem/year	0 mrem/year ^a	0 mrem/year					
"Air pathway"	TEDE whole body							
DOE Order 435.1 IV.P.(1)(c)	\leq 20 pCi/m ² /s	0.006 pCi/m ² /s	0.14 pCi/m ² /s					
"Radon"								
DOE Manual 435.1-1 IV.P.(2)(h) "Inadvertent Intruder"								
Chronic Exposure	100 mrem/year	mrem/year 0.456 mrem/year 0.627 mrem year						
Acute Exposure (1 event)	500 mrem	6.75E-03 mrem						
DOE Manual 435.1-1 IV.P.(2)(g) "Water Resources Protection"								
Ra-226 & Ra-228	5 pCi/L	0 pCi/L ^b	0 pCi/L ^b					
Beta emitters	4 mrem/year	0 mrem/year ^b	0 mrem/year ^b					
Gross alpha	15 pCi/L	0 pCi/L ^b						
Uranium	30 μg/L	0 μg/L ^b	0 μg/L ^b 4					

Site Conditions –Then And Now

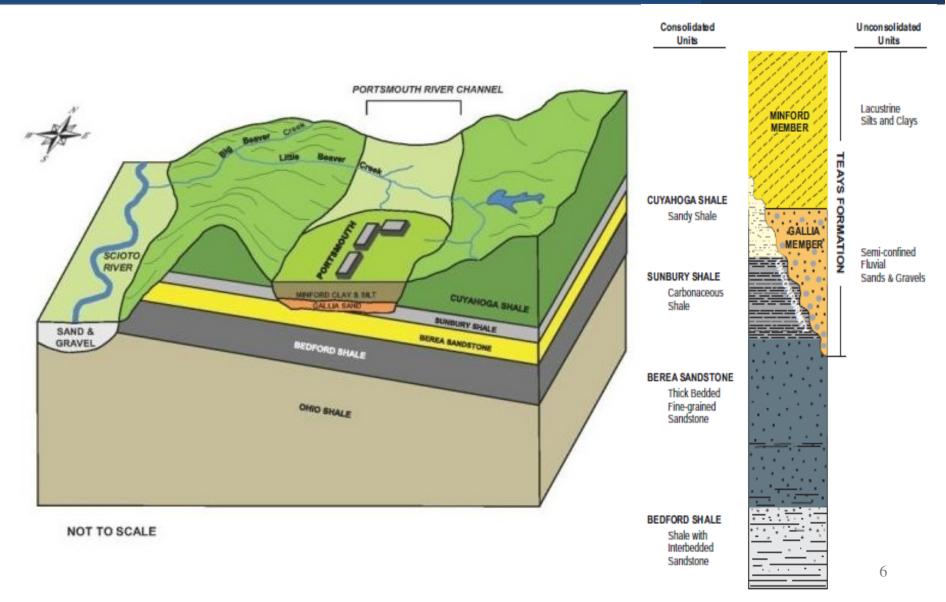






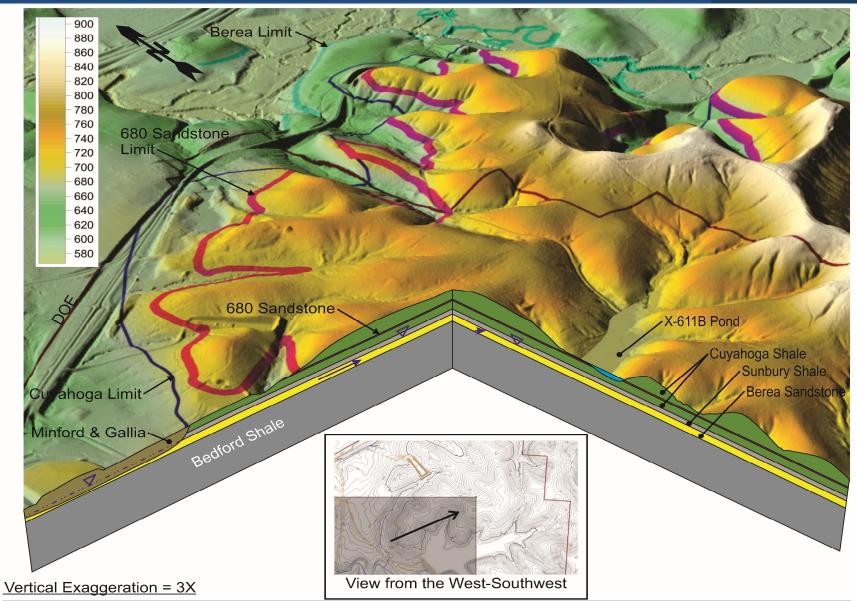
Geology





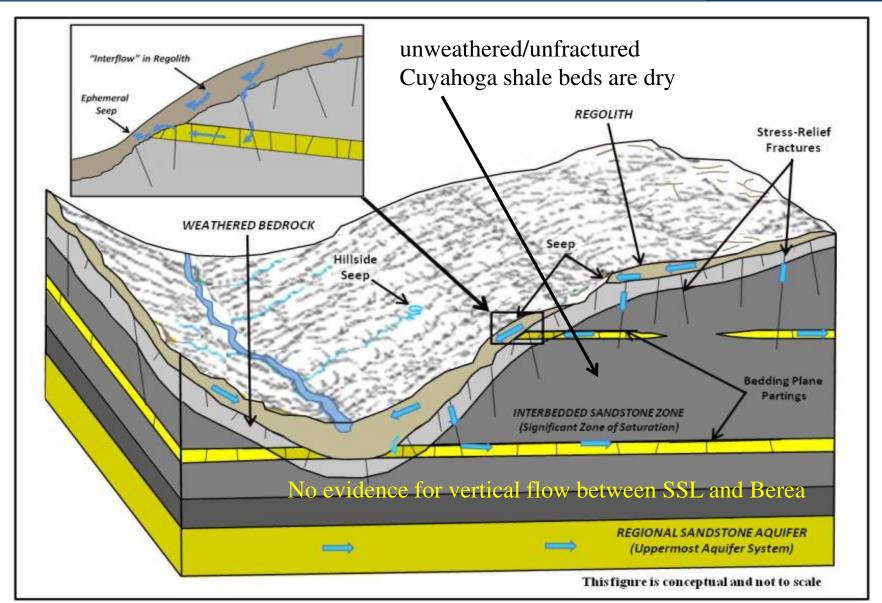
Area D Topography & Geology





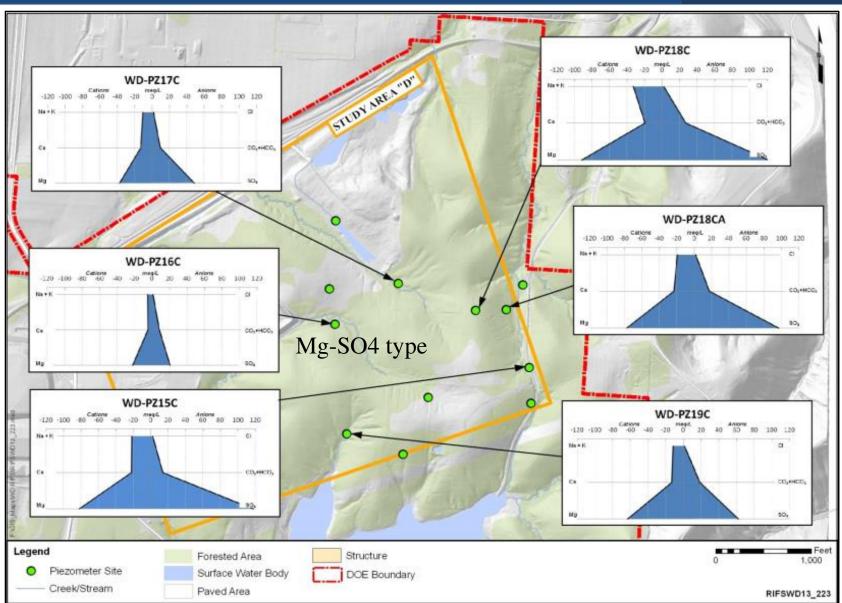
Area D Conceptual Flow in Cuyahoga





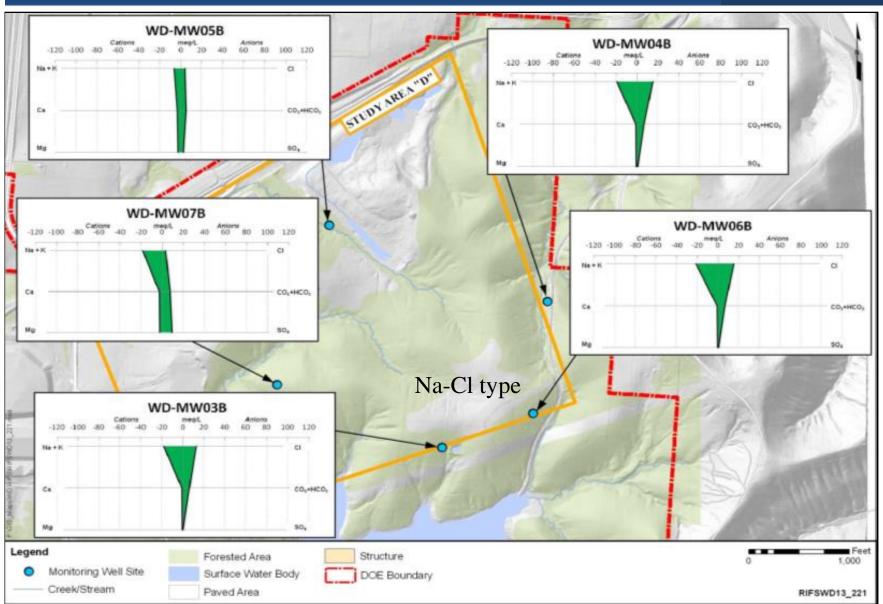
680 SSL Groundwater Ions





Berea Groundwater Ions





OSWDF – Liner & Cap

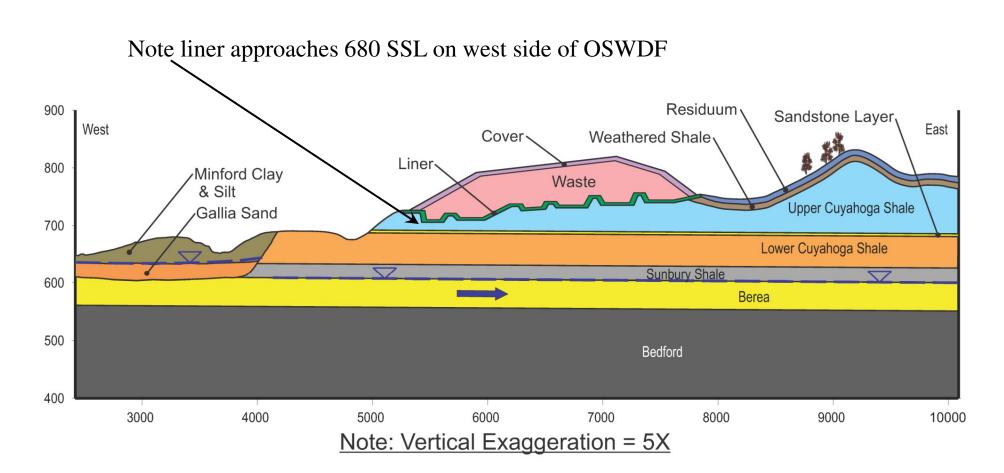






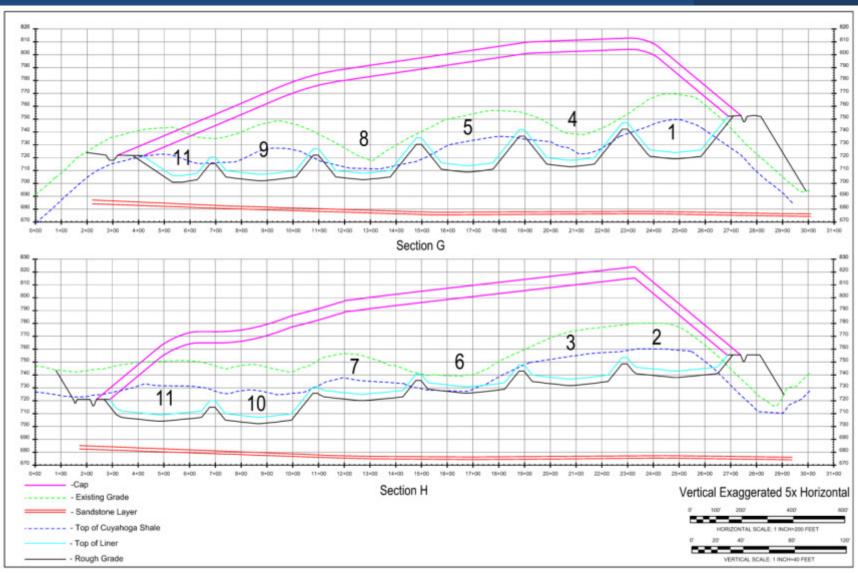
OSWDF Post Closure





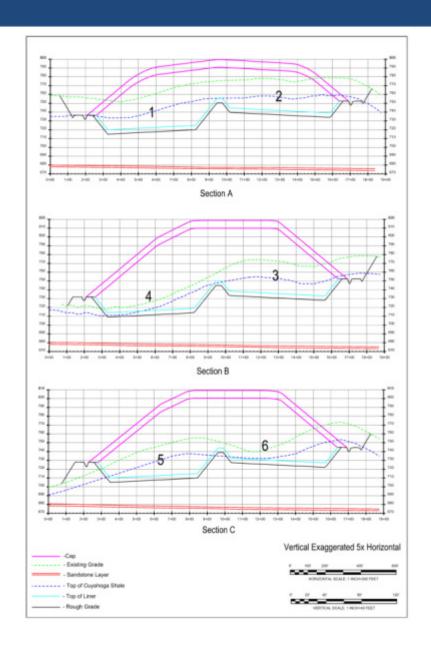
OSWDF W to E Sections

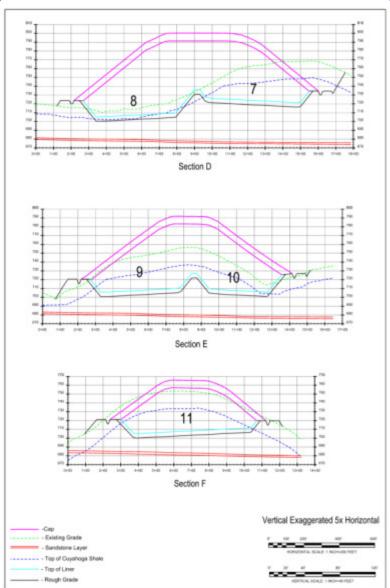




OSWDF N to S Sections



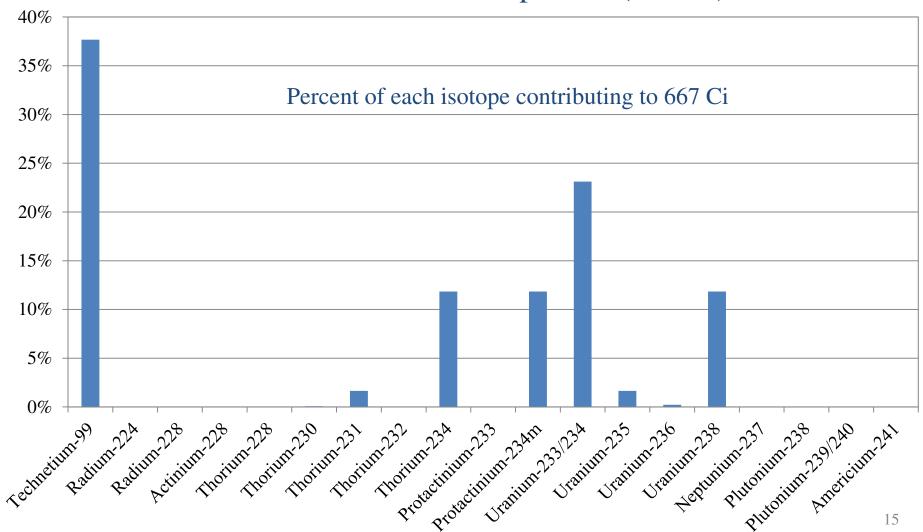




Inventory Estimates – S2



> maximum values with no barrier present (667 Ci)

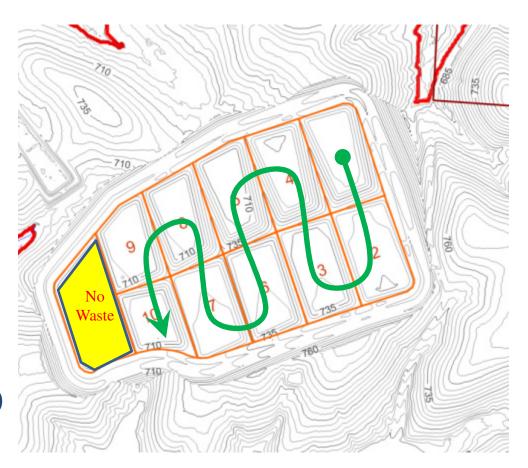


OSWDF S2 Inventory Loading



Reasonable Inventory Case

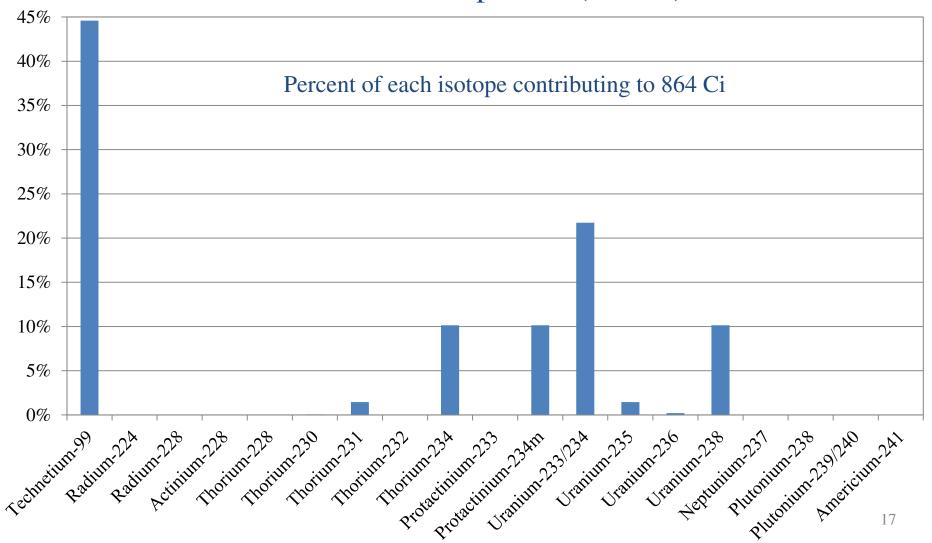
✓ OSWDF Cells 1-10
loaded with S2
inventory according
to D&D schedule
(approximately 80%
of Ci in eastern cells;
most distance
between liner and 680
SSL)



Inventory Estimates – S4



maximum values with barrier present (864 Ci)

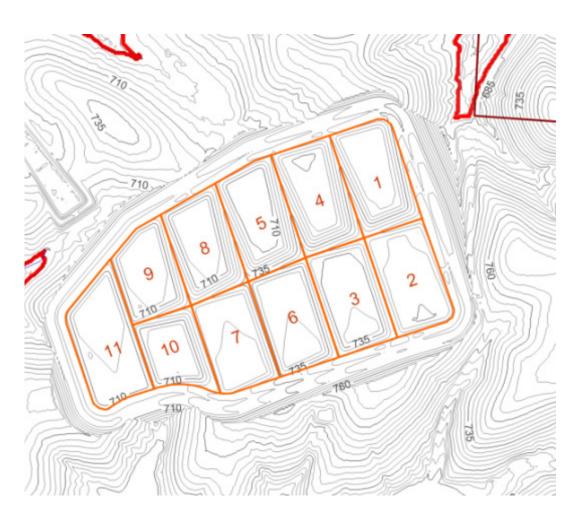


OSWDF S4 Inventory Loading



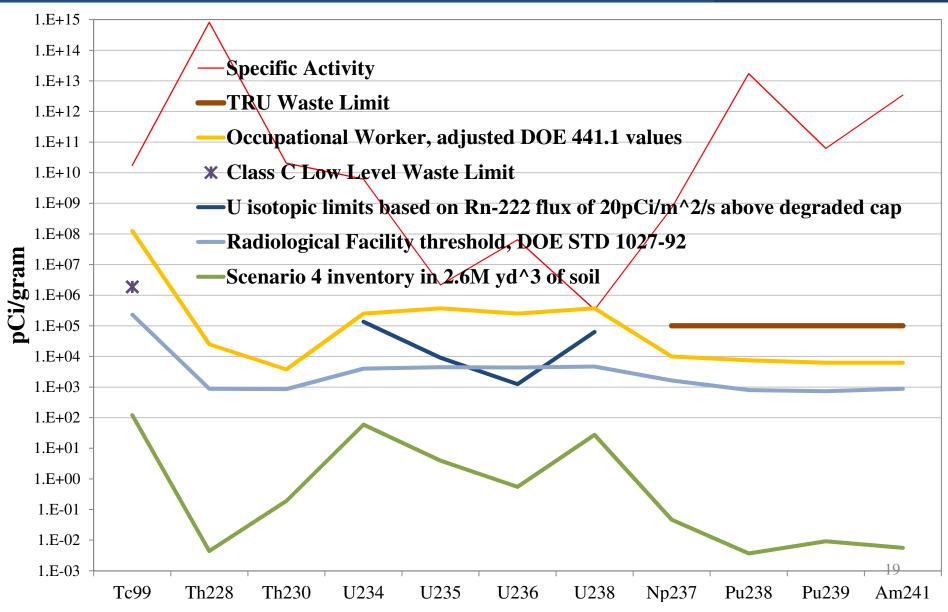
Conservative Inventory Case

✓ OSWDF Cells 1-10 evenly loaded with S4 inventory; and 11th cell added with 1/10 of S4 Ci (over 50% of Ci in western cells; closest to 680 SSL)



S4 Inventory vs. Other Limits





Key Assumptions



- > Estimates of the Curie Inventory
 - Biased high using maximum nuclide values for waste streams
 - Developed with and without the nickel barrier material
 - Review and revise, as needed, when additional data are available

➤ OSWDF Source Cases

- Reasonable Case: 10 cells loaded per D&D schedule (80% of S2 Ci in the eastern 5 cells; greatest distance from 680 SSL)
- Conservative Case: 10 cells evenly loaded with S4; 11th cell with 1/10 S4
 Ci (most Ci in the western cells; closest to 680 SSL)

➤ 100% of Nuclide Mass Available to Leach

- ✓ No credit for mass removed during operations
- ✓ Batch Leach Tests (BLT) show <100% of mass is leachable

➤ Lowest U K_d from BLT Evaluated

✓ Produces maximum U concentration in OSWDF leachate

Key Assumptions



➤ Degradation of HDPE Liners

- ✓ 201-500 years: water flux in and out = 0.05 in/yr
- ✓ >500 years: water flux in and out = 1.08 in/yr

➤ Hydraulic Conductivity in 680 SSL

✓ Biased to fast transport times; based on pump test from 5-ft zone centered on 2-ft 680 SSL (flow along bedding interface)

> Yield from 680 SSL under Uncased Well Scenario

 Model overestimates leakage from 680 SSL (5.4%) by setting input file to perform simultaneous drawdown in 680 SSL and Berea SS

> Heterogeneity in the Rock Layers

 Sample points used to assess rock properties and mineral composition may not cover the full range of hydraulic and geochemical conditions in the rock layers

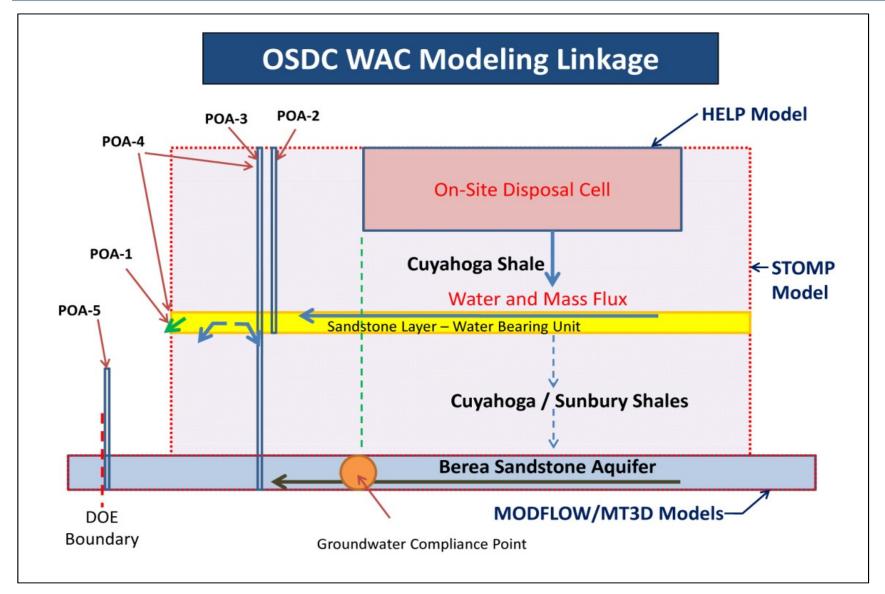
QA/QC of Models



- > HELP software (Version 3)
 - ✓ Developed for EPA by U.S. Army Engineer Waterways Experiment Station
 - ✓ Verification & validation (Schroeder et al., 1994)
 - ✓ Functionality & output documented by Jacobs (2015)
- > STOMP software (Version 1.3)
 - ✓ Developed at PNNL under NQA-1-2000 software requirements
 - ✓ Verification & validation (White & Oostrom, 2000 & 2006)
 - ✓ Functionality & output documented by Jacobs (2015)
- ➤ GoldSim software (Version 10.50 SP3)
 - ✓ Developed by GoldSim Technology Group
 - ✓ Verified & validated at SRS per software QA Plan (Swingle 2006)
 - ✓ Functionality & dose results documented by SRNL (2012)

Hydrology Models & POAs





HELP Model Results – Summary Of Initial Runs



Water Flow Direction		Period (Years after cell closure)	0-200 201-500 501-1000 1001-1000			1001-10000
	Precipitation	39.52				
***	Runoff		3.25	3.25	3.25	3.25
	Evapotranspiration	Topsoil/soil	27.74	27.74	27.74	27.74
		Sand				
		Bio-Intrusion Prevention Layer (Cobble)				
	Drain Collection	Drainage Layer	8.54	8.49	7.02	5.55
		FML				
		GCL				
		Compacted Clay/Contour Clay				
Flux Rate into Waste (in/yr)		1.00E-05		0.05	1.08	2.99
		Waste				
		soil				
	Drain Collection	Leachate Collection Drainage Layer	0.00001	0.00061		
		FML				
		GCL				
Drain Collec		Leak Detection Dranage Layer	0	0.0006		
		FML				
		GCL				
		Compacted Clay				
Flux Rate through Clay Liner (in/yr)			0.00	0.05	1.08	2.92
↓		Cuyahoga Shale				

STOMP Model – Geological Layers

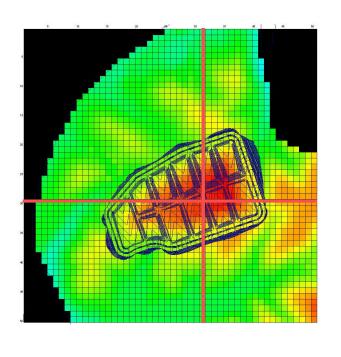


Current Condition	Thickness (ft)	Future Condition with OSDC
Residuum Soil	15	
Weathered Shale	510	OSDC
Weathered/Fractured Shale	520	
Upper Cuyahoga Shale	2040	Upper Cuyahoga Shale
Sandstone Layer (partial saturated zone)	2	Sandstone Layer
Lower Cuyahoga Shale	45	Lower Cuyahoga Shale
Sunbury Shale (Organic Black Shale)	20	Sunbury Shale
Berea Sandstone (Regional Aquifer - but very low yield below OSDC)	30	Berea Sandstone

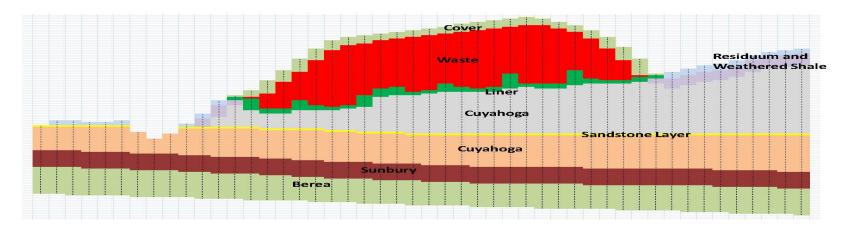
STOMP Model - Grid Dimensions



	Number of Model Columns (along the X Direction)	50	
Model Grid	Number of Model Rows (along the Y Direction)	50	
Model Grid	Number of Model Layers (along the Z Direction)	124	
	Number of Model Nodes	310,000	
	Number of Active Nodes	182,550	
Model Grid Size	X (uniform)	100	
	Y (uniform)	100	
(ft)	Z (uniform)	2	
	Number of Rock/Soil Types	10	
		Cell Cover	
		Waste	
		Liner-Clay	
Matarial (Daak/Sail)		Residuum Soil	
Material (Rock/Soil)	Doole/Soil Tymas Modeled	Weathered-Shale	
Туре	Rock/Soil Types Modeled	Upper Cuyahoga-Shale	
		Sandstone-Layer	
		Cuyahoga-Shale	
		Sunbury-Shale	
		Berea-Sandstone	

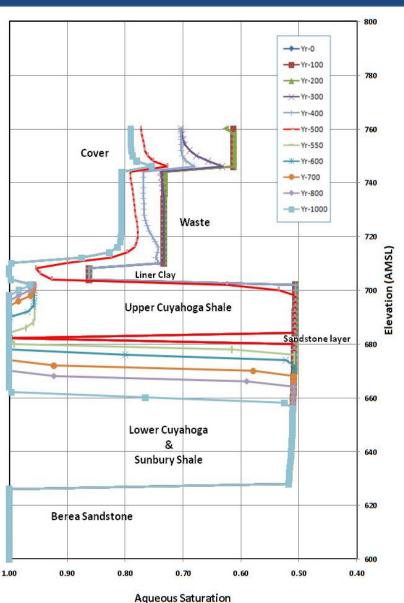


West East



STOMP Model Results - Saturation Front Evaluation





Flow to 680 SSL

- ✓ Infiltration rate assumed to increase to 1.08 in/yr at year 500.
- ✓ 550 to 600 yrs to reach the SSL; based on 20-ft distance between clay liner and SSL

> Flow below 680 SSL

- ✓ Saturation front extends only 20 ft below 680 SSL after 1,000 years
- ✓ Saturation front does not reach Sunbury Shale or Berea Sandstone within 1,000 years
- ✓ Saturation front predicted to reach Berea within 10,000 years, but Tc-99 and U do not reach Berea SS

STOMP Model Summary of Input Data

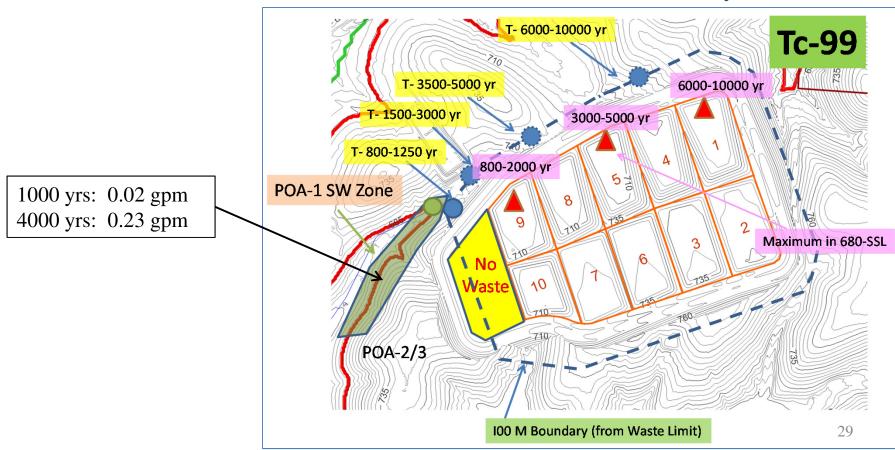
	Reasonable Case (kg/L)					
	Tc-99	U-234	U-235	U-236	U-238	
Cell 1	1.82E-08	3.07E-08	6.32E-06	2.86E-08	2.91E-04	
Cell 2	9.30E-09	1.57E-08	3.24E-06	1.47E-08	1.49E-04	
Cell 3	3.85E-09	6.51E-09	1.34E-06	6.08E-09	6.17E-05	
Cell 4	8.78E-09	1.48E-08	3.06E-06	1.39E-08	1.41E-04	
Cell 5	7.38E-09	1.25E-08	2.57E-06	1.16E-08	1.18E-04	
Cell 6	9.96E-10	1.68E-09	3.47E-07	1.57E-09	1.60E-05	
Cell 7	1.01E-09	1.70E-09	3.50E-07	1.59E-09	1.61E-05	
Cell 8	1.05E-09	1.78E-09	3.67E-07	1.66E-09	1.69E-05	
Cell 9	8.40E-10	1.42E-09	2.93E-07	1.32E-09	1.35E-05	
Cell 10	8.34E-10	1.41E-09	2.90E-07	1.31E-09	1.34E-05	
		Conserv	ative Case	e (kg/L)		
	Tc-99	U-234	U-235	U-236	U-238	
Cell 1	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 2	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 3	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 4	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 5	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 6	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 7	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 8	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 9	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 10	6.76E-09	9.09E-09	1.76E-06	2.36E-09	7.83E-05	
Cell 11	4.56E-09	6.13E-09	1.18E-06	5.44E-09	5.28E-05	

Fluid State	Fluid Flow	Stratigraphic Layer	Kx	Ку	Kz	U K _d	Tc K _d
Tidia State	Tidia Tiow	Stratigrapine Layer	cm/s	cm/s	cm/s	L/kg	L/kg
Sat/Unsat	\downarrow	Waste Layers	1.0E-04	1.0E-04	1.0E-04	395 & 14.6	2.03
Unsat	\downarrow	Clay Liner	1.0E-07	1.0E-07	1.0E-07	14.2	3.79
Unsat	\	Upper Cuyahoga Shale Beds	3.2E-06	3.2E-06	3.2E-07	6.60	4.60
Sat/Unsat	$\leftrightarrow \downarrow$	680 SSL	1.0E-4 to 1.4E-2	1.0E-4 to 1.4E-2	1.0E-05	68	3.38
Unsat		Lower Cuyahoga Shale Beds	1.3E-08	1.3E-08	1.3E-09	6.60	4.60
Unsat	↑	Sunbury Shale	4.4E-08	4.4E-08	4.4E-09	757	217
Sat	\leftrightarrow	Berea Sandstone	1.9E-04	1.9E-04	3.8E-05	1.54	3.34

STOMP Model Results – Reasonable Inventory Loading



- Reasonable (*Likely And More Protective*) Case
 - POA-1: surface-water zone west of OSWDF
 - POA-2: max value along perimeter as a function of time
 - POA-3: fluid does not reach Berea Sandstone within 1000 years



STOMP Model Results – Conservative Inventory Loading



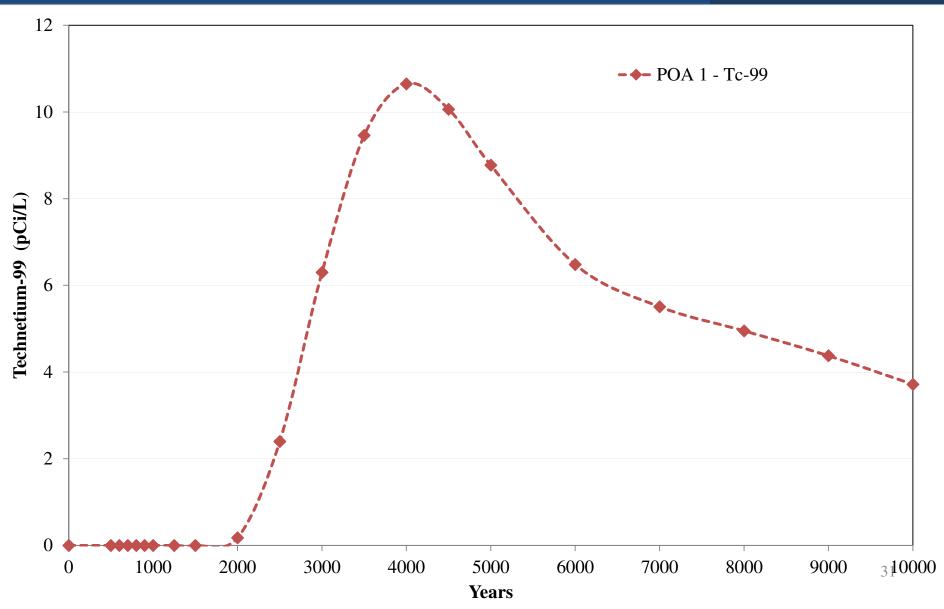
- Conservative (*Unlikely And Less Protective*) Case
 - POA-1: surface-water zone west of OSWDF
 - POA-2: max value along perimeter as a function of time
 - POA-3: fluid does not reach Berea Sandstone within 1000 years

T-8000-10000 yr Tc-99 T- 5000-7000 vr T- 1500-4500 yr 10000 vr 8000-9000 yr 4500-7000 vr POA-1 SW Zone Maximum in 680-SSL 2500-4000 yr 600-2000 yr POA-2/3 30 100 M Boundary (from Waste Limit)

1000 yrs: 0.02 gpm 4000 yrs: 0.23 gpm

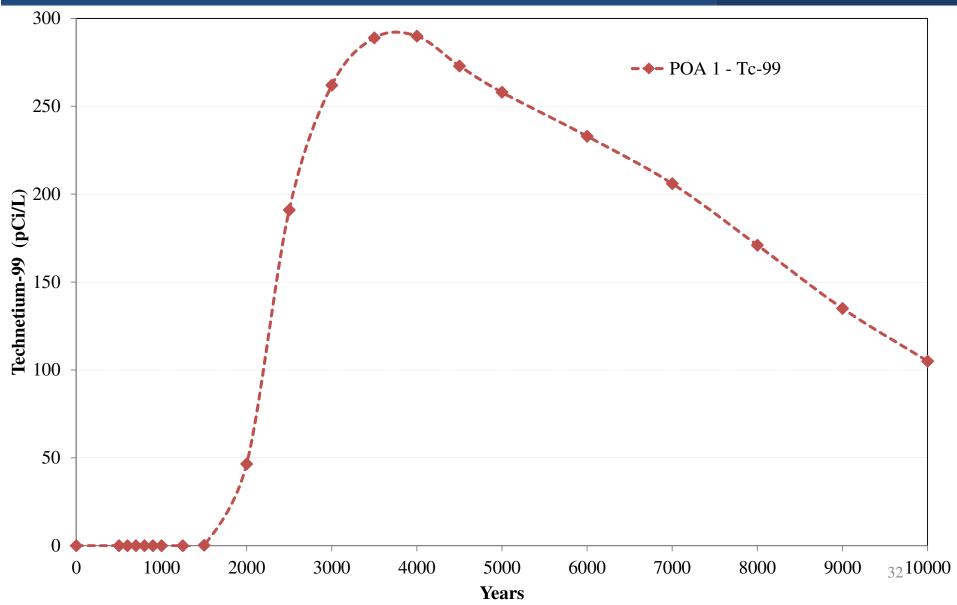
STOMP Model Results – POA1 Reasonable Inventory Loading





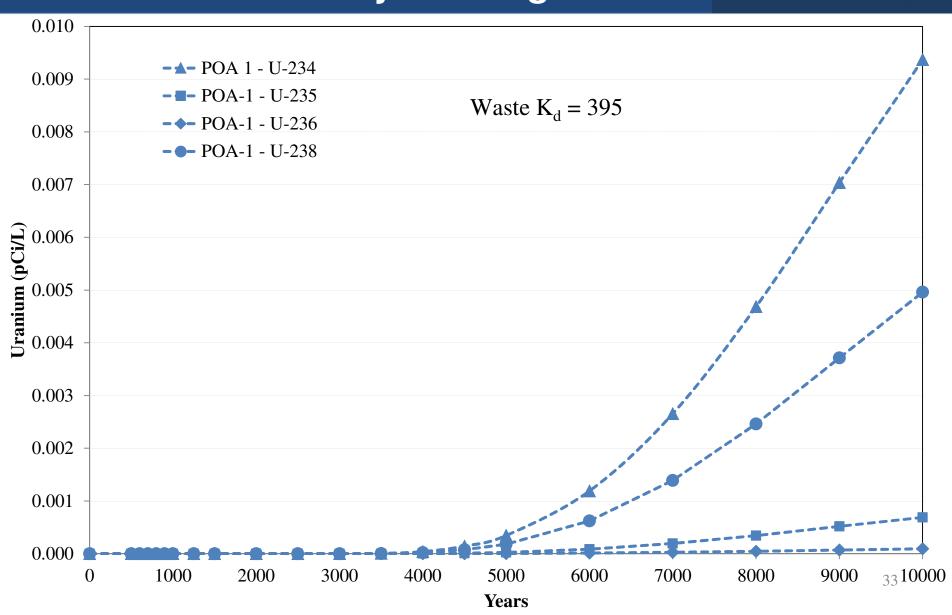
STOMP Model Results – POA1Conservative Inventory Loading





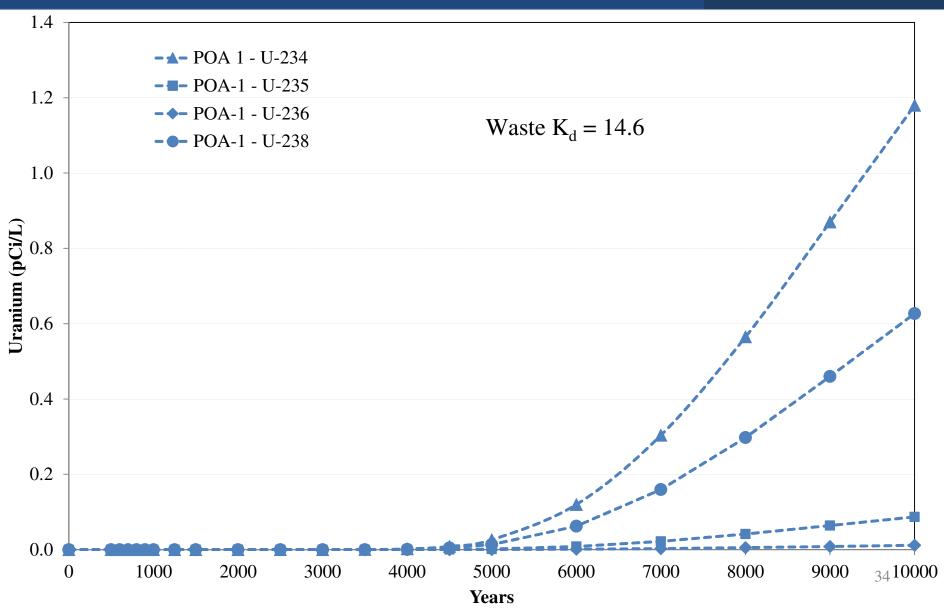
STOMP Model Results – POA1 Reasonable Inventory Loading





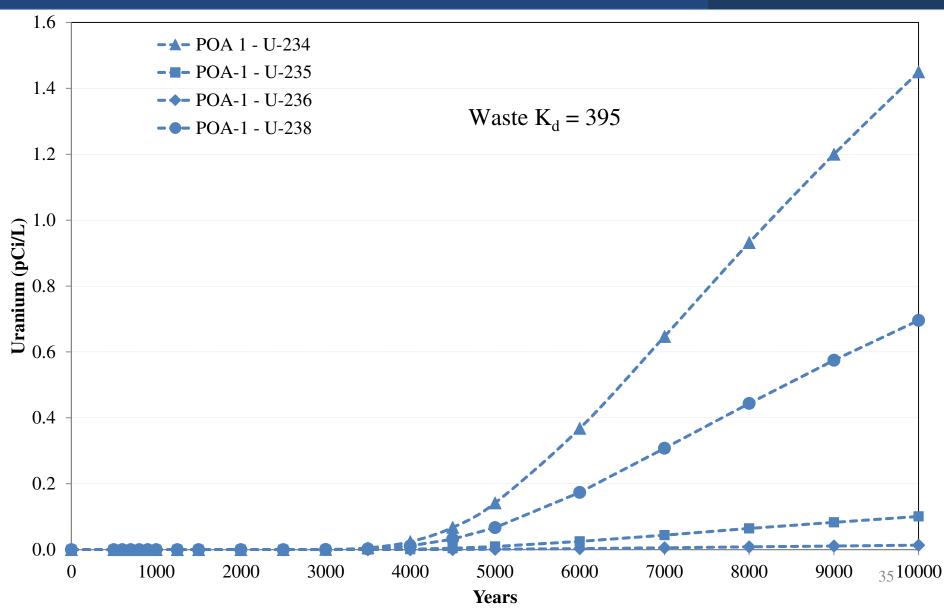
STOMP Model Results – POA1Reasonable Inventory Loading





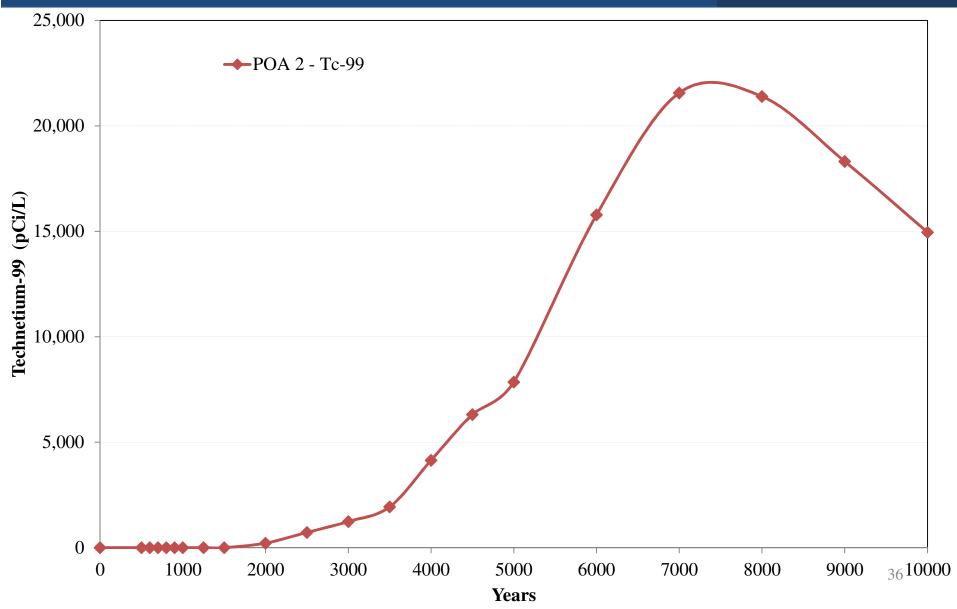
STOMP Model Results – POA1Conservative Inventory Loading





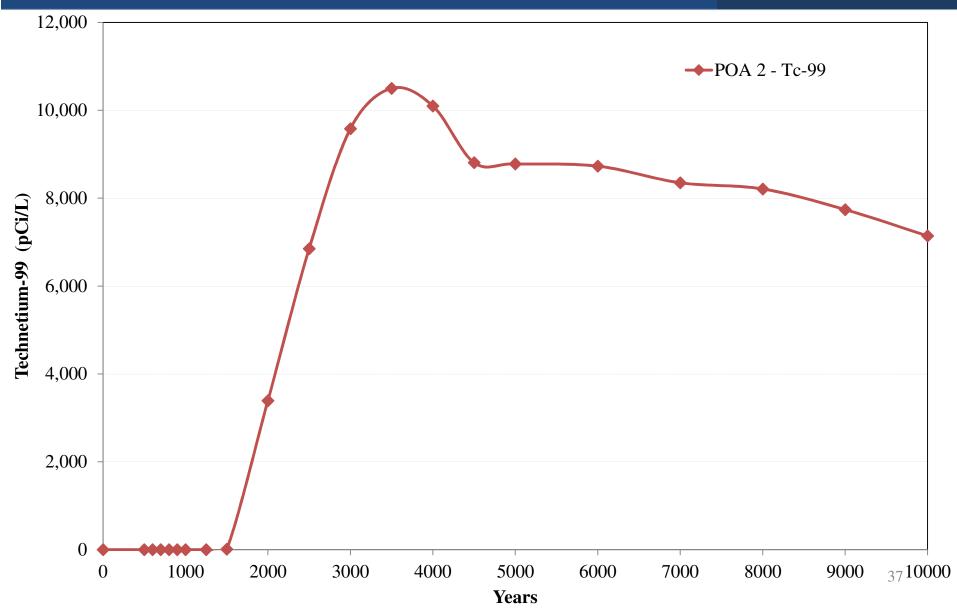
STOMP Model Results – POA2 Reasonable Inventory Loading





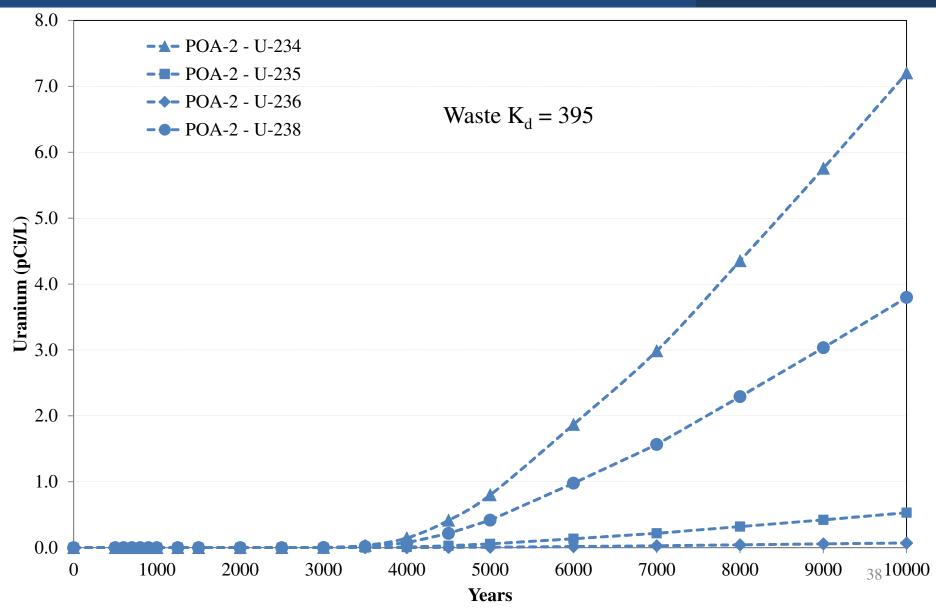
STOMP Model Results – POA2 Conservative Inventory Loading





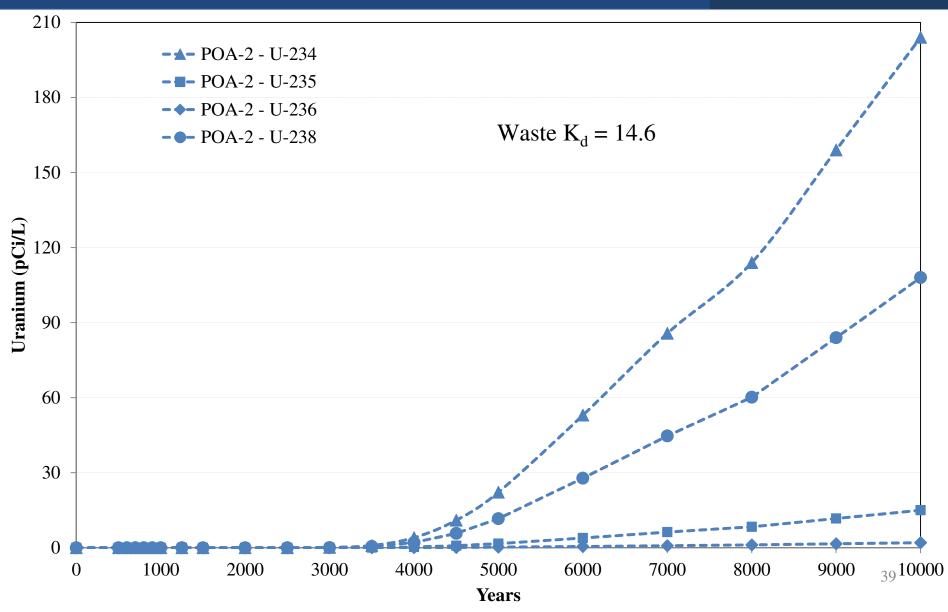
STOMP Model Results – POA2 Reasonable Inventory Loading





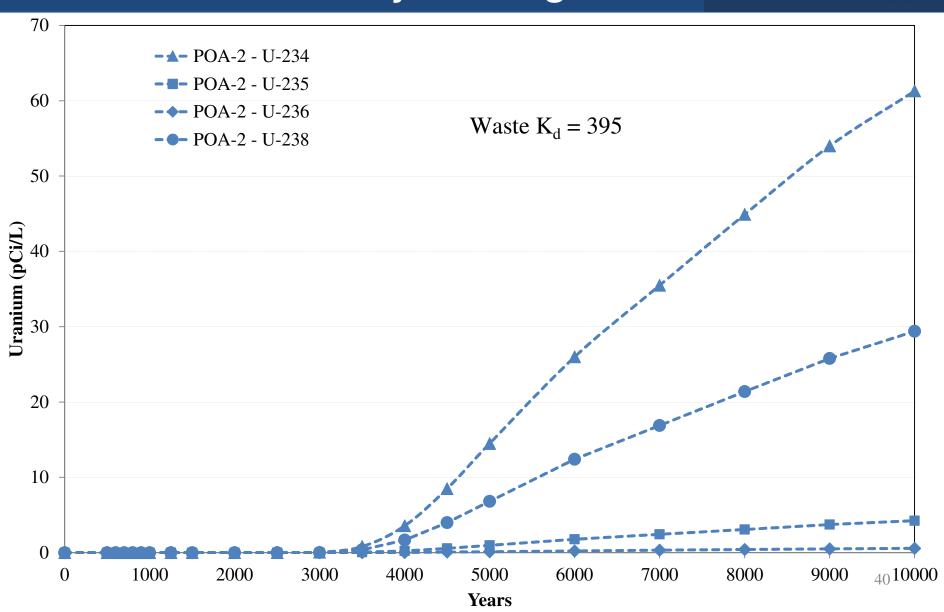
STOMP Model Results – POA2 Reasonable Inventory Loading





STOMP Model Results – POA2 Conservative Inventory Loading





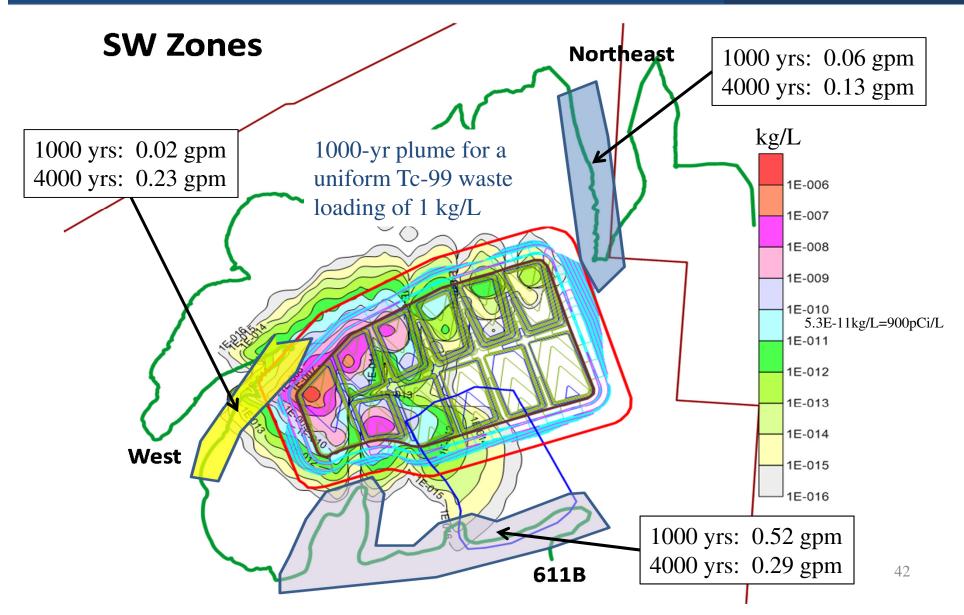
STOMP Model – Additional Sensitivity Analysis



- ➤ Assessment of alternate POA-1 surface water locations NE and S of OSWDF
- ➤ Lower U and Tc K_d values in the Cuyahoga Formation shale and sandstone beds
- ➤ Peak concentrations for U-238 and Tc-99 beyond 10,000 years
- ➤ Variation in hydraulic conductivity, initial saturation and recharge rate surrounding OSWDF

STOMP Model – Alternate POA-1 locations





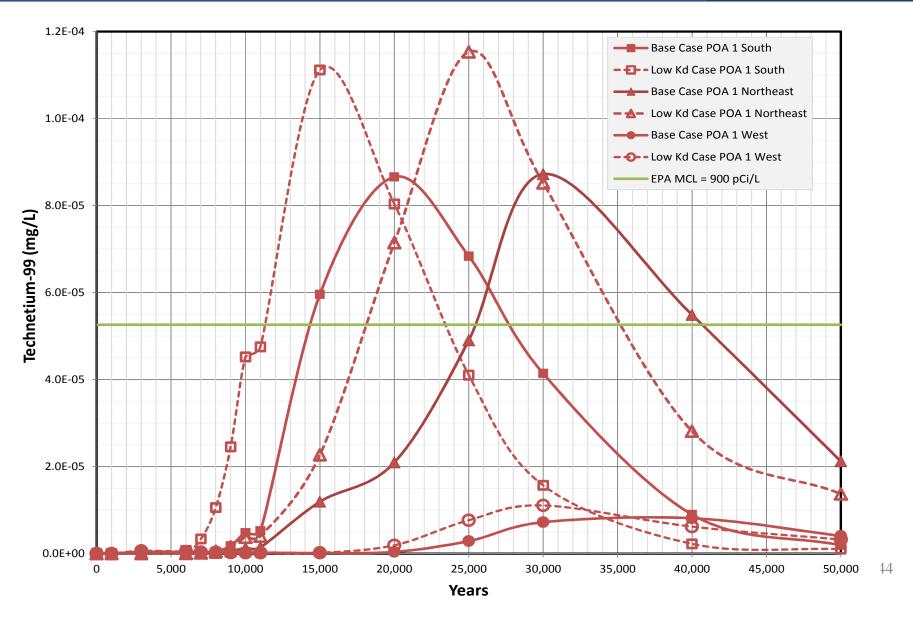
STOMP Model – Lower K_d values



	Geologic Unit	Base Case (L/kg)	Low K _d Case (L/kg)	
Technetium-99	Source/Waste	2.03	2.03	
	Cuyahoga shale	4.60	3.17	
	Cuyahoga sandstone	3.38	3.27	
Uranium-238	Source/Waste	395	395	
	Cuyahoga shale	6.60	2.04	
	Cuyahoga sandstone	68.0	64.4	

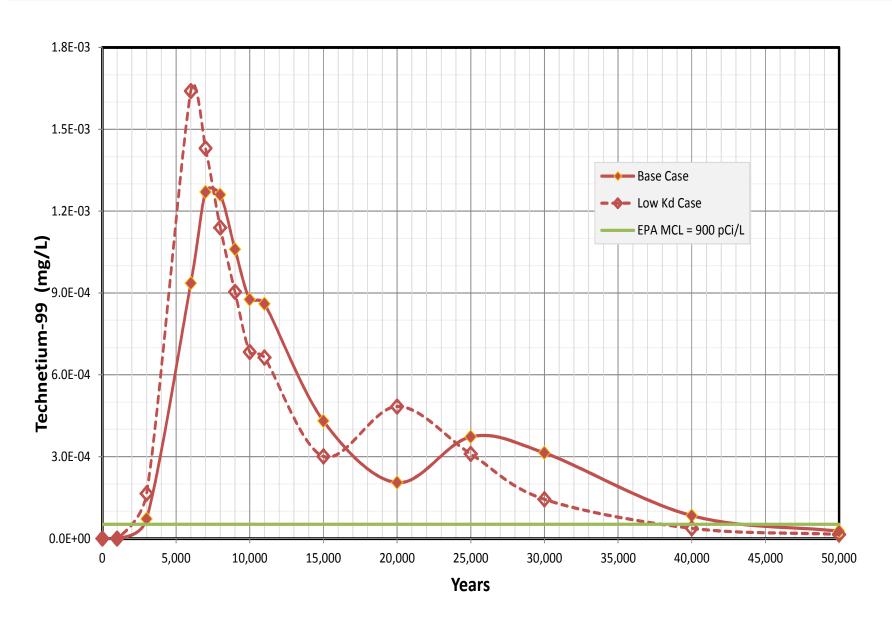
STOMP Model – POA1 locations Variation in K_d values





STOMP Model – POA2 locations Variation in K_d values

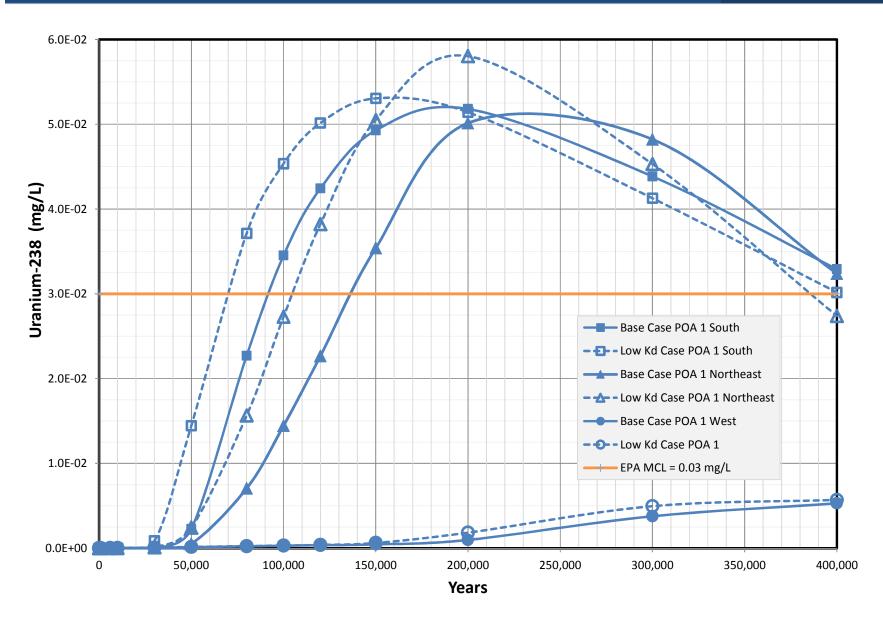




STOMP Model – POA1 locations Variation in K_d values

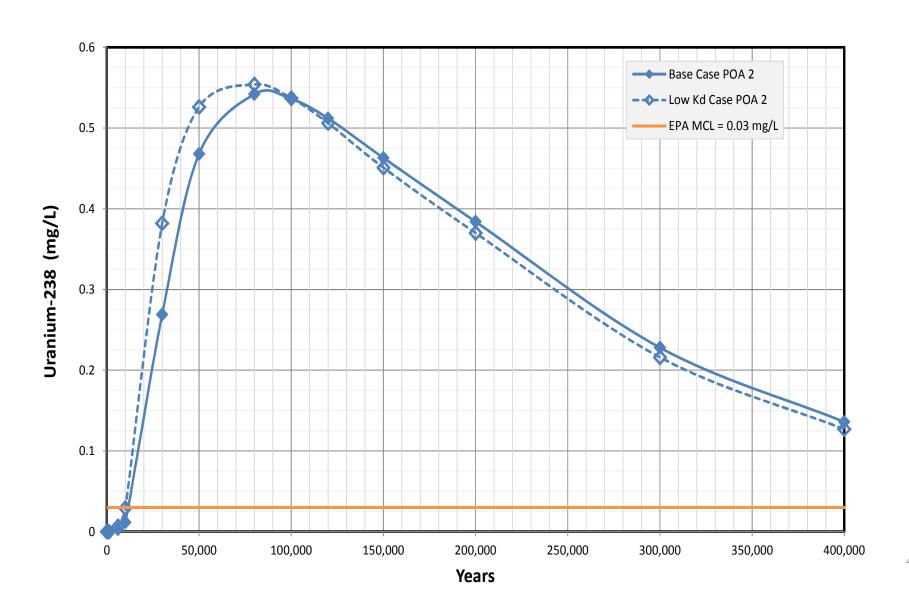


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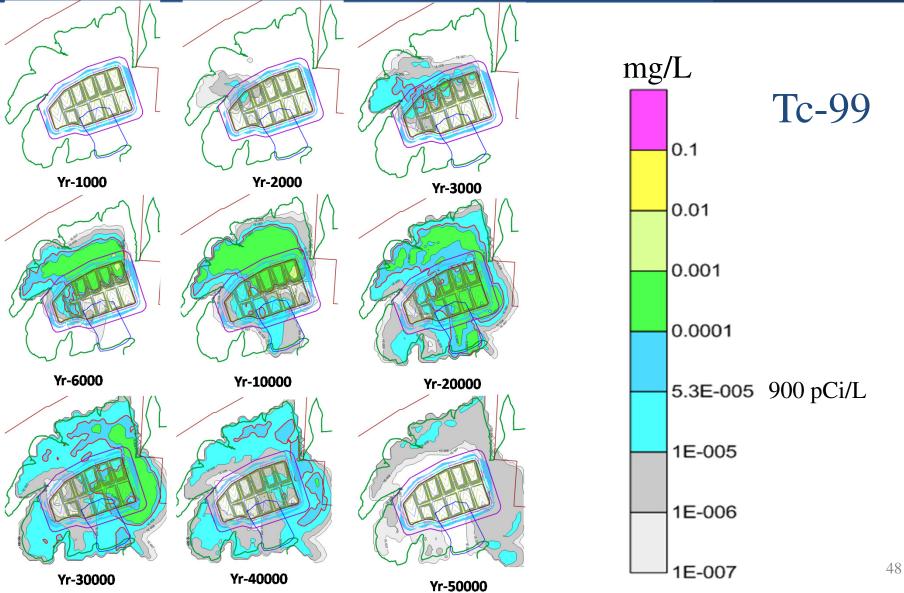
STOMP Model – POA2 locations Variation in K_d values





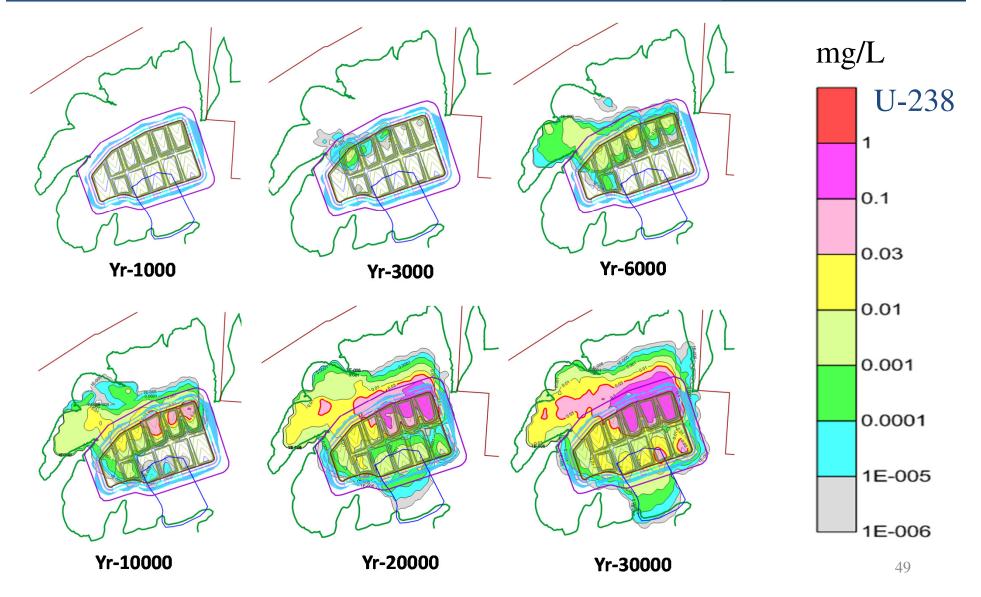
STOMP Model – Base Case Tc-99 plume in 680 SSL





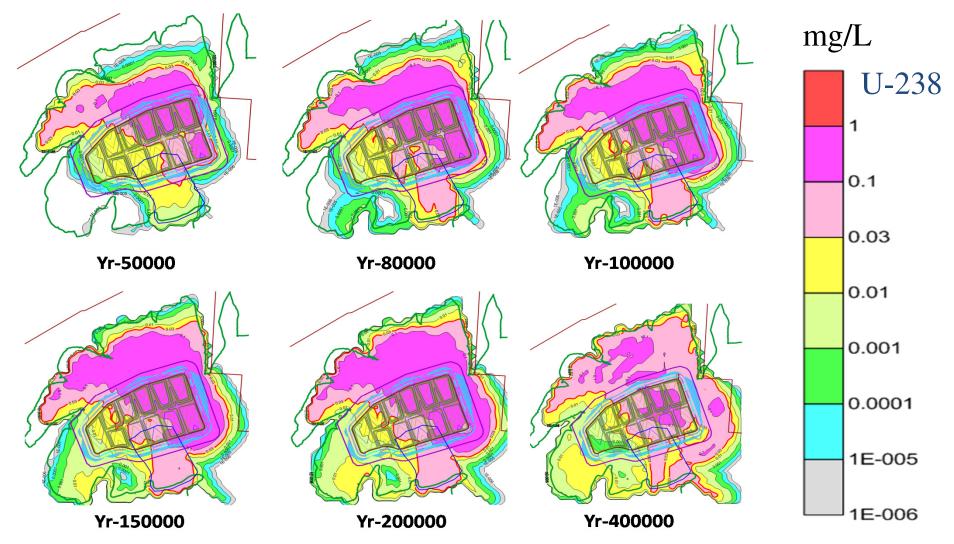
STOMP Model – Base Case U-238 plume in 680 SSL





STOMP Model – Base Case U-238 plume in 680 SSL







> Resident Farmer Scenario

- ✓ Surface Water From POA-1:
 - Farm pond receives water seeping from 680 sandstone layer (seepage accounts for 5% of pond water) and pond water used to irrigate garden and pasture and water livestock
 - **Exposure scenarios:**
 - Ingestion of vegetables, soil, beef, milk, poultry, and eggs
 - Inhalation of garden water and dust
 - Direct exposure to garden soil
- ✓ Groundwater From POA-3:
 - Groundwater from a well in the Berea Sandstone used for domestic purposes
 - **Exposure scenarios:**
 - Ingestion of groundwater
 - Inhalation of shower water



- ➤ GoldSimTM software (Version 10.50 SP3) used to implement resident farmer exposure scenario dose equations (used in DOE complex for PAs at LANL, Nevada, SRS, Hanford)
- ➤ STOMP used for flow and transport of parent radionuclides to each POA including parent decay (used as input to the GoldSimTM all-pathways dose model)
- ➤ Daughter ingrowth calculated within GoldSimTM model for the parent nuclide at the POA to give the total dose as parent plus all daughters



➤ Base Case

- ✓ Reasonable inventory
- ✓ Berea cased well (no radionuclides reach Berea in 10,000 years)
- ✓ Nominal uranium source K_d (395 mL/g)
- ✓ Base case transfer factors
- ✓ Typical Person (50th percentile) exposure parameters

Sensitivity Cases

Sensitivity	Change from Base Case
1	Conservative inventory
2 *	Berea uncased well: 95% Berea (POA-3); 5% from 680 sandstone layer along 100 m boundary (POA 2)
3	Low uranium source K _d (14.6 mL/g)
4	Most recently published IAEA Transfer Factors where available
5	Reference Person (95th percentile) exposure parameters

^{*} Sensitivity requested by OEPA to include in WD RI/FS report

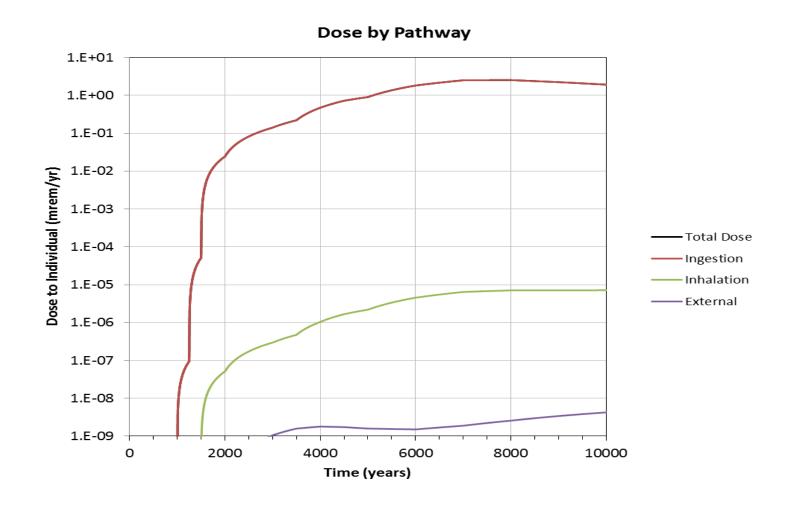


➤ Dose from all pathways much less than 25 mrem/yr

	Maximum Dose during 1,000-Year Period of Assessment		Maximum l Ti	Dose at Any me	Pathway Giving	Nuclide Giving
Case	(mrem/yr)	(year)	(mrem/yr)	(year)	Highest Dose	Highest Dose
Base Case	1.5E-14	1,000	0.0020	4,000	Vegetable	Tc-99
Sensitivity #1	1.4E-10	1,000	0.064	10,000	Vegetable	Tc-99
Sensitivity #2	5.9E-11	1,000	2.55	8,000	Water	Tc-99
Sensitivity #3	1.5E-14	1,000	0.038	10,000	Vegetable	U-234
Sensitivity #4	3.9E-14	1,000	0.0052	4,000	Vegetable	Tc-99
Sensitivity #5	1.1E-13	1,000	0.015	4,000	Vegetable	Tc-99

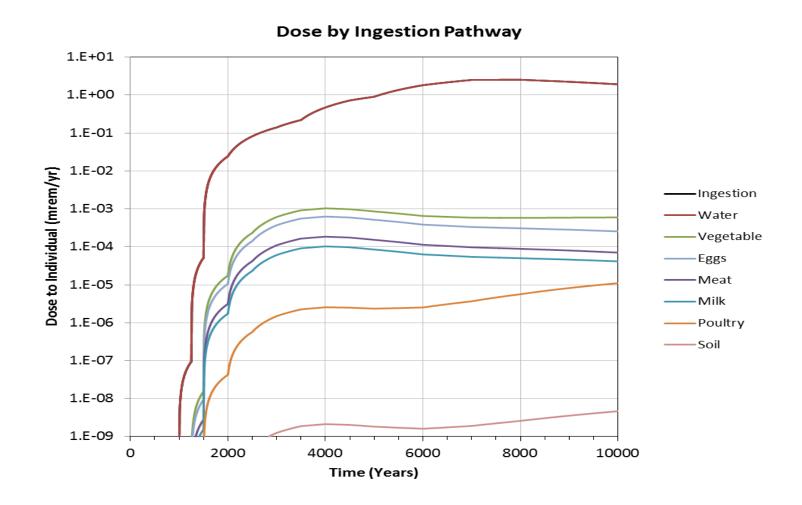


- ➤ Sensitivity Case #2
 - ✓ Uncased well with groundwater from POA-2 leaking into POA-3



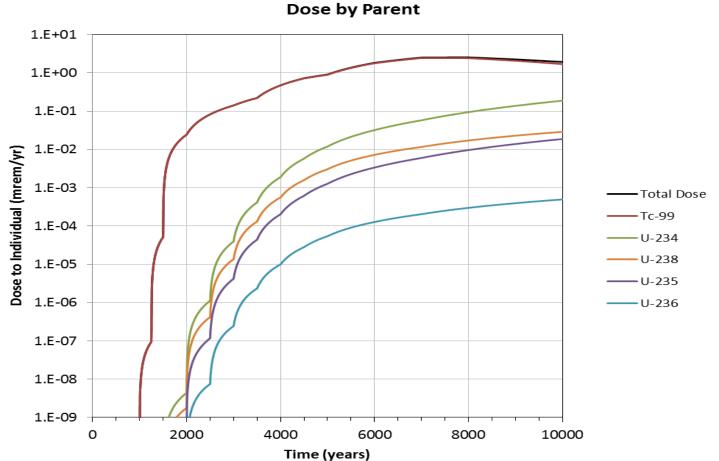


- ➤ Sensitivity Case #2
 - ✓ Uncased well with groundwater from POA-2 leaking into POA-3





- ➤ Sensitivity Case #2
 - ✓ Uncased well with groundwater from POA-2 leaking into POA-3



Air Pathway Analysis



- ➤ Volatilization/transport/inhalation air pathway from waste through cover to atmosphere is incomplete, as none of the radionuclides in the projected waste streams are volatile under ambient conditions
- The Air Pathway Analysis was performed as part of the All-Pathways Analysis (Resident Farmer Scenario)
 - ✓ POA-1:
 - **❖** Air Pathway exposure scenarios:
 - Inhalation of garden water
 - Inhalation of garden dust
 - ✓ POA-3:
 - ❖ Air Pathway exposure scenario:
 - Inhalation of shower water

Air Pathway Results



> Results

- ✓ Dose from air pathway much less than 10 mrem/yr
- ✓ Greatest dose of 7.2E-06 mrem/yr from Sensitivity #2 was predominately from inhalation of shower water (POA 3)

	Maximum Air during 1,000-Y Assess	Year Period of	Maximum Air at Any		
Case	(mrem/yr)	(year)	(mrem/yr)	(year)	POA
Base Case	0	NA	3.4E-09	10,000	1
Sensitivity #1 (Conservative)	0	NA	4.8E-07	10,000	1
Sensitivity #2 (Uncased Well)	0	NA	7.2E-06	10,000	1 & 3
Sensitivity #3 (Low U K _d)	0	NA	4.0E-07	10,000	1
Sensitivity #4 (IAEA TF)	0	NA	3.4 E-09	10,000	1
Sensitivity #5 (Ref. Person)	0	NA	3.4E-09	10,000	1

Intruder Analysis



- ➤ Inadvertent Intruder Scenarios Evaluated:
 - ✓ Acute well drilling (exposure to cuttings during drilling):
 - ***** External exposure to cuttings
 - **❖** Soil inhalation
 - Soil ingestion
 - ✓ Acute discovery (external exposure during excavation):
 - External exposure to shielded waste
 - ✓ Chronic post-drilling (drill cuttings used in garden):
 - Vegetable ingestion
 - Soil ingestion
 - ***** External exposure to soil
 - Soil inhalation

Intruder Analysis – Results Summary PORTS

> Results

- ✓ Chronic dose much less than 100 mrem/yr
- ✓ Acute dose much less than 500 mrem

Time (years)	Chronic Post Drilling (mrem/yr)	Acute Well Drilling (mrem)	Acute Discovery (mrem)	
100	0.448	5.43E-03	2.68E-06	
200	0.449	5.51E-03	3.08E-06	
300	0.450	5.61E-03	3.55E-06	
400	0.450	5.72E-03	4.09E-06	
500	0.451	5.84E-03	4.68E-06	
600	0.452	5.97E-03	5.33E-06	
700	0.452	6.11E-03	6.04E-06	
800	0.453	6.25E-03	6.80E-06	
900	0.454	6.41E-03	7.61E-06	
1,000	0.455	6.57E-03	8.47E-06	
1,100	0.456	6.75E-03	9.37E-06	

Dose Assessment for STOMP sensitivity analysis



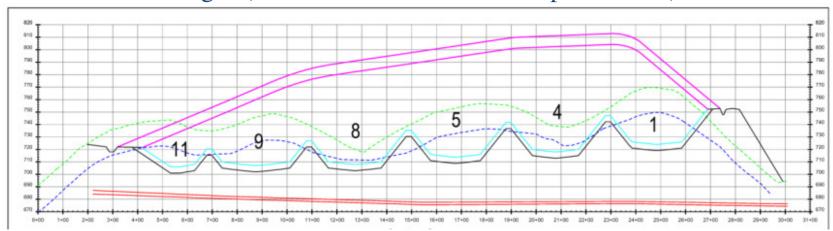
➤ Dose estimate beyond 10,000 years

Nuclide	Model Run	Years	POA-1	Pond		POA-2	A-2 POA-2/3 mix	
Nucliue			pCi/L	pCi/L	mrem/year	pCi/L	pCi/L	mrem/year
	Base	7,000	5.51E+00	2.76E-01	1.01E-03	2.16E+04	1.17E+03	2.44E+00
Tc-99	Casea	10,000	3.72E+00	1.86E-01	6.85E-04	1.50E+04	8.10E+02	1.70E+00
Lo	Low K _d	6,000				2.81E+04	1.52E+03	3.18E+00
	Case ^b	25,000	1.97E+03	9.85E+01	3.63E-01			
	Base Case	10,000	9.37E-03	4.69E-04	2.37E-04	7.20E+00	3.89E-01	1.88E-01
U-234 ^c	Low K _d	80,000				3.52E+02	1.90E+01	9.22E+00
	Case	200,000	3.68E+01	1.84E+00	9.33E-01			
U-238	Base Case	10,000	4.96E-03	2.48E-04	3.76E-05	3.80E+00	2.05E-01	2.90E-02
	Low K _d	80,000				1.86E+02	1.00E+01	1.42E+00
	Case	200,000	1.95E+01	9.75E-01	1.48E-01			

Hypothetical Bathtub Scenario



- ➤ Post-500 year failure of liner seam at Cell 11 low point
 - Waste is saturated above this point and discharges at a rate of 3.33 gpm to the storm water drainage ditch
 - 3.33 gpm is the entire fluid volume derived from an infiltration rate of
 1.08 inch/year over the cap area covering the waste
 - Annual rainfall of 40 inch/year; assume 20 inch/year is run off due to degraded cap (dilution of seep 1/20)
 - Use initial Tc-99 (26,000 pCi/L) and U (141 ug/L) leachate values for S2 inventory as discharge values (assume no depletion for 500 years)
 - Diluted concentrations in drainage ditch: Tc-99 = 1,300 pCi/L;
 U = 7 ug/L (assume farmer uses this for pond water)



Hypothetical Bathtub Scenario



> Dose estimate for farmer using water in drainage ditch

Nuclide	Model	Years	POA-1 (pCi/L)	Pond		Leachate	Drainage	Channel
	Run	rears		pCi/L	mrem/yr	pCi/L	pCi/L	mrem/yr
Tc-99	Base Case ^a	4,000	1.06E+01	5.30E-01	1.96E-03			
	Bathtub ^b	??				2.60E+04	1.30E+03	4.81E+00
U-234	Base Case	4,000	4.01E-05	2.01E-06	5.16E-07			
	Bathtub	??				9.00E+01	4.50E+00	1.16E+00
U-238	Base Case	4,000	2.09E-05	1.05E-06	1.52E-07			
	Bathtub	??				4.62E+01	2.31E+00	3.36E-01

Radon Analysis



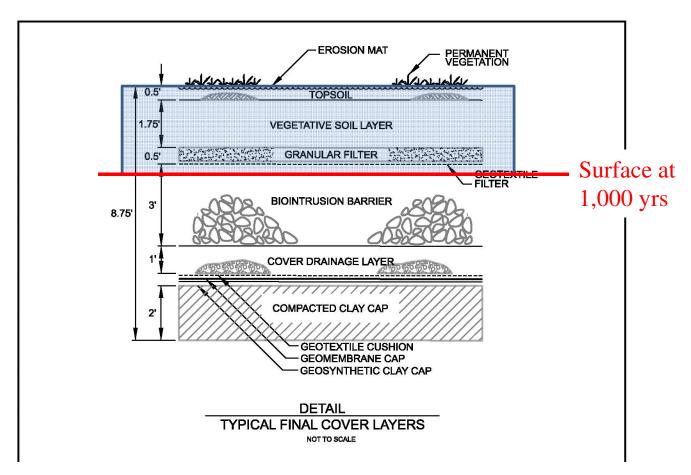
➤ Initial Conditions

- ✓ Ra-226 activity is zero, as uranium was separated from daughter products during production of UF₆ feed.
- ✓ S4 inventory estimate (max values with barrier)
 - U-238 = 87.6 Ci
 - U-234 = 188 Ci
 - Th-230 = 0.601 Ci
- ✓ 4 M yd³ of waste (all cells) at bulk density of 1.6 g/cm³
 - U-238 = 18 pCi/g
 - U-234 = 39 pCi/g
 - Th-230 = 0.12 pCi/g

Radon Analysis



- ➤ Conditions 1,000 years after Facility Closure
 - ✓ Degraded Cap: erosion of topsoil, vegetative and granular drainage layers; HDPE layer ineffective; bio-intrusion barrier intact



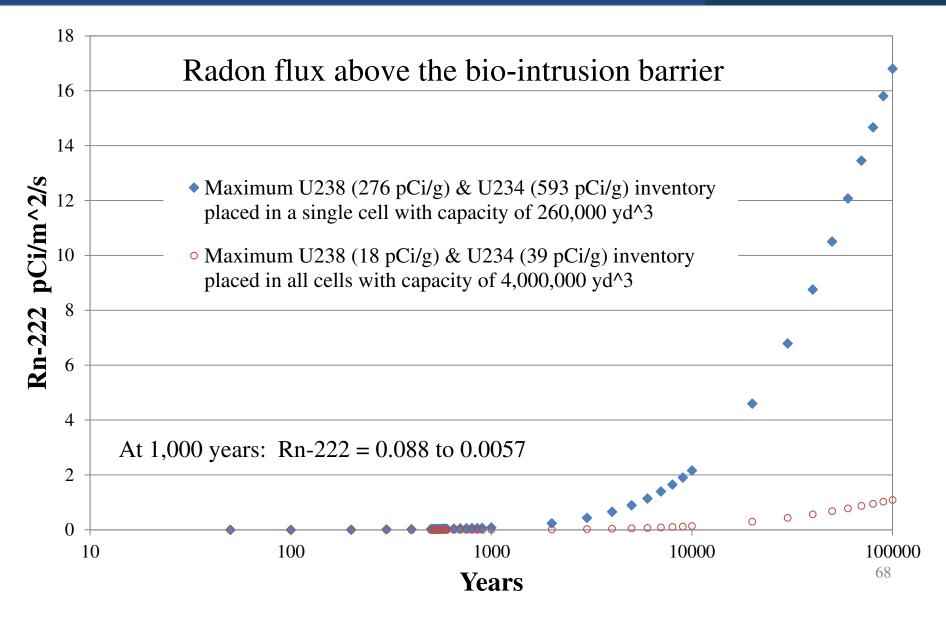
Radon Analysis



- ➤ References for Radon Flux Analysis
 - ✓ Equations in Radon Attenuation Handbook for Uranium Mill Tailings Cover Design (NRC 1984)
 - ✓ Material property values for the OSWDF (Geosyntec 2012)
 - ✓ Scenario 4 radionuclide inventory used in Bateman equations to estimate the Ra-226/U-238 activity ratio over a period of 10,000 years (SRNL 2013)

Radon Analysis – Results





2014/2015 Accomplishments



- ➤ Proposed Plans (PP) for Waste Disposition and Process Building D&D were concurred by Ohio EPA October 2014.
- ➤ Public Meeting on the proposed remedial actions occurred on November 17, 2014.
- Formal Public Comment period on PP closed March 11, 2015.
- ➤ DAS for design and construction approved March 13, 2015.
- ➤ Ohio EPA concurred/approved Records of Decision:
 - Waste Disposition ROD June 30, 2015.
 - Process Building ROD July 30, 2015.
- CAMU approval by Ohio EPA in the WD ROD:
 - OSWDF Treatment, Storage, and Disposal CAMU.
 - IMTA Treatment and Storage CAMU.
- CD-0/1/3A approved for CAP 1 August 28, 2015
- ➤ Initial RD/RA WP approved September 21, 2015

Proposed 6-year Schedule



